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THREE PIECE DISTANCE GOLF BALL

CROSS-REFERENCE TO RELATED APPLIATIONS

A claim of benefit is made to U.S. Provisional Application Serial No. 60/138,078 filed June 8, 1999, the contents of which are incorporated herein by reference. This is a continuation-in-part application of the provisional application filed June 8, 1999, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The instant invention is directed to golf balls, and more particularly to a ball having the optimal cover hardness, cover composition, size of thread windings, center compression, center weight, center diameter, and dimple configuration to provide superior playability capabilities with respect to softness and spin without sacrificing superior distance capabilities.

DESCRIPTION OF THE PRIOR ART

It is well known in the golf industry that the distance a ball travels is one of the key features that distinguish one ball from the next. In the golf ball business, distance sells.

There are a number of physical properties that affect the performance of a golf ball. The core of the golf ball is the source of the ball's major elastic properties. In a three-piece golf ball, the core is comprised of the center and thread windings

layer of the golf ball. Among other things, the core affects the ball's "feel" and its initial velocity. The initial velocity is the velocity at which the golf ball travels immediately following impact. The initial velocity can be grouped with launch angle and spin to describe the ball's initial conditions, or the conditions exhibited by the ball immediately after impact. The initial conditions along with dimple pattern determine the ball's trajectory and ultimately its distance. The "feel" is the overall sensation transmitted to the golfer through the golf ball at impact. The overall construction of the ball influences the "feel" of a golf ball. Properties such as cover hardness, compression, and rebound can be used to gauge the response of a golfer to a ball's construction. But ultimately, the ball's "feel" can only be determined by the avid golfer. One property commonly tested by golfers to judge the "feel" of a ball is the sound made at impact between the ball and the club. This sound or "click" provides the golfer with a lasting impression of the ball's feel. Generally, lower cover hardness, compression, and rebound give the golfer an impression of a softer "feel" and a corresponding lower, softer click.

Until the late 1960's, most golf balls were constructed with a thread wound core and a cover of compounds based on natural balata and gutta percha or synthetic transpolyisoprene. These golf balls have been and are still known to provide good flight distance. Additionally, due to the relative softness of the balata cover, skilled golfers can impart various spins on the ball in order to control the ball's flight path (e.g., "fade" or "draw") and "bite" characteristics upon landing on a green.

"Fade" is a term used in golf to describe a particular golf ball flight path that is characterized by a curved or arched flight exhibited towards the latter portion of the flight path that veers off from the center line of the initial flight path to the opposite side from which the golfer stands. Upon contact with the ground, a ball hit with a "fade" will stop in a relatively short distance. This is a result of an open club face at impact imparting more spin and a higher trajectory than normal.

"Draw" is the term used in golf to describe a particular golf ball flight path that is characterized by a curved or arched flight exhibited towards the latter portion of the flight path that veers off from the center line of the initial flight path to the same side on which the golfer stands. Upon contact with the ground, a ball hit with a "draw", unlike that of a ball hit with a "fade", will roll for a considerable distance. This is a result of a closed club face at impact imparting less spin and a lower trajectory than normal.

“Check” or "bite" is the term used in golf to describe the effect of imparting a substantial amount of backspin to an approach shot into a green that causes the golf ball to stop abruptly upon contact with the green.

Another desirable feature of balata-based compounds is that they are readily adaptable to molding. These compounds therefore can be compression molded about a spherical core to produce golf balls.

Though possessing many desirable properties, there are substantial drawbacks to use of balata or transpolyisoprene-based compounds for golf ball covers. From a manufacturing standpoint, balata-type materials are expensive

and the manufacturing procedures used are time consuming and labor-intensive, thereby adding to the material expense. From a player's perspective, golf balls constructed with balata-based covers are very susceptible to being cut from mishits and being damaged from sharp grooves on a club face. As a result, they have a relatively short life span.

In response to these drawbacks to balata-based golf ball covers, the golf ball manufacturing industry has shifted to the use of synthetic thermoplastic materials, most notably ionomers sold by E. I. DuPont De Nemours & Company under the name SURLYN®. Surlyn is an ionomeric resin that is an ionic copolymer of an olefin having from about 2 to about 8 carbon atoms, such as ethylene, and a metal salt of an alpha, beta-ethylenically unsaturated mono- or dicarboxylic acid such as acrylic acid, methacrylic acid, or maleic acid. The pendent ionic groups in the ionomeric resins interact to form ion-rich aggregates contained in a non-polar polymer matrix. Metal ions, such as sodium, zinc, or lithium are used to neutralize some portions of the acid groups in the copolymer resulting in a thermoplastic elastomer exhibiting enhanced properties such as improved durability.

Thread wound balls with ionomer covers are less costly to manufacture than balls with balata covers. They are more durable and produce satisfactory flight distance. However, these materials are relatively hard compared to balata and thus lack the "feel" of a balata covered golf ball.

In an attempt to overcome the negative factors of the hard ionomer covers, DuPont introduced low modulus SURLYN® ionomers in the early 1980's. These

SURLYN® ionomers have a flexural modulus of from about 3000 to about 7000 PSI and hardness of from 25 to about 40 as measured on the Shore D scale - ASTM 2240. The low modulus ionomers are terpolymers, typically of ethylene, methacrylic acid and n or iso-butylacrylate, neutralized with sodium, zinc, magnesium or lithium cations. E.I. DuPont De Nemours & Company has disclosed that the low modulus ionomers can be blended with other grades of previously commercialized ionomers of high flexural modulus from about 30,000 to 55,000 PSI to produce balata-like properties. However, "soft" blends, typically 52 Shore D and lower (balata-like hardness), do not exhibit good physical properties and are prone to cut and shear damage.

The low modulus ionomers when used without high stiffness blends produce covers with very similar physical properties to those of balata, including poor cut and shear resistance. Worse, wound balls with these covers tend to go "out-of-round" quicker than wound balls with balata covers. Blending with hard SURLYN® ionomers was found to improve these properties.

Historically, in addition to manipulating the cover composition of a golf ball, golf ball manufacturers have also varied the size and winding conditions of the thread windings layer as well as the weight of the center in three-piece golf balls in an effort to design a golf ball with superior ball performance. Various efforts have been made to select the optimal winding pattern as well as the ideal thread dimension and winding tension.

For many years golf ball manufacturers have also investigated changing dimple configurations in an effort to design a ball with superior distance

capabilities. Dimples are the surface indentations or depressions on a golf ball. Specifically, ball manufacturers have looked to dimple configurations in an effort to design a ball with superior distance capabilities. Many efforts have been made to select the optimum number, size and shape of dimples as well as their disposition around the outer surface of a generally spherically shaped golf ball. However, a problem with the prior art dimple configurations is that they fail to take into account other features of the ball, such as core size, core compression and cover hardness, which also influence how far a ball will travel.

Dimples on golf balls are typically circular in elevation cross section, but a number of other designs are also utilized, including truncated cones, dimples within dimples, elliptical surfaces, hemispherical (or single radius) dimples, and dual radius dimples. For example, U.S. Patent No. 4,979,747 shows dimples having a frusto-contical elevation view cross section, and U.S. Pat. No. 5,005,838 shows dimples having complex shapes.

Different dimple shapes have different aerodynamic properties, and therefore, result in different performance characteristics. For example, a single radius dimple provides a more gradual entry of the airflow into the dimple, while a dual radius dimple provides a more abrupt entry of the airflow into the dimple. (A single radius dimple is one in which the elevation cross sectional shape of the dimple can be described by one radius, and dual radius dimple is one in which the elevation cross section is described by two radii.)

Generally, it has been found that the single radius dimple is the most optimal dimple shape for a high performance three-piece wound golf ball. By

contrast, the dual radius dimple is the most optimal shape design for two-piece distance balls for providing the desired golf ball flight trajectory. These dimple choices are based on the current view that the higher spinning performance balls require a more gradual entry of the airflow into the dimple to create the desired aerodynamic effects, whereas the low spinning distance ball requires a more abrupt entry of the airflow into the dimple to create the desired aerodynamic effect.

There are a number of hybrid type balls which do not fall squarely within either the three-piece performance category or the two-piece distance category. For example, two-piece performance balls and three-piece distance balls are hybrid balls which behave like performance balls for certain shots and like distance balls for other shots. As used herein the term "hybrid ball" is used to refer to a two piece performance ball, a three-piece distance ball, or any other ball which behaves like a performance ball for certain shots and like a distance ball for other shots.

It has been found, for instance, that a dimple pattern utilizing dual radius dimples allows for a lower more boring trajectory for a distance two-piece ball, whereas a pattern utilizing single radius dimples allows for a more consistent flight trajectory for high performance three-piece balls.

A need exists for a dimple pattern (and dimple shape) which takes into account the unique characteristics of the hybrid ball (i.e. the fact that it performs as a distance ball for certain shots, and as a performance ball for other shots) to provide optimum performance. The goal is to provide a ball that (i) provides slightly longer overall distance than a ball utilizing either all single radius dimples

or all dual radius dimples, and (ii) has a significantly lower trajectory, as exhibited by the lower rear trajectory value.

As is well known in the art, ball manufacturers are bound by regulations of the United States Golf Association (USGA) which control many characteristics of the ball, including the size and weight of the ball, the initial velocity of the ball when tested under specified conditions, the overall distance the ball travels when hit under specified test conditions, and the ball's aerodynamic symmetry. Under USGA regulations, the diameter of the ball cannot be less than 1.680 inches, the weight of the ball cannot be greater than 1.620 ounces avoirdupois, the initial velocity of the ball cannot be greater than 250 feet per second when tested under specified conditions (with a maximum tolerance of +2%), the driver distance cannot exceed 280 yards when tested under specified conditions (with a test tolerance of +6%), and the ball must perform the same aerodynamically regardless of orientation. It should be noted that while the USGA sets a limit for the distance a ball can travel under set test conditions, there is no upper limit on how far a player can hit a ball.

OBJECT OF THE INVENTION

Accordingly, it is an object of the instant invention to optimize the combination of center weight, center compression, size and winding conditions of the windings dimple, configuration, cover composition, and cover hardness to provide a three-piece golf ball, which travels great distances, and at the same time complies with USGA regulations.

It is another object of the instant invention to provide a three-piece golf ball that has a soft "feel" in combination with superior distance capabilities.

It is yet another object of the instant invention to provide a three-piece golf ball having a synthetic cover material that achieves the sound, feel, and playability and flight performance qualities of balata covered golf balls.

It is still a further object of the instant invention is to provide a three-piece golf ball having superior distance, trajectory and flight stability.

Another object of the instant invention is to provide a three-piece golf ball having a surface divided into a plurality of polygonal configurations or shapes for the location of dimples for enhancing the aerodynamic properties of the golf ball.

It is yet another object of the present invention to provide a golf ball dimple pattern that optimizes the performance characteristics of the instant invention.

It is still another object of the present invention to provide a hybrid golf ball that provides a slightly longer overall distance and a lower trajectory than the prior art hybrid balls.

It is still a further object of the invention to provide a golf ball having a dimple pattern that incorporates dimples of different sizes to maximize the aerodynamic qualities for each such dimple shape.

It is yet another object of the present invention to provide a golf ball having superior distance, trajectory and flight stability.

SUMMARY OF THE INVENTION

The invention achieves the above-described objectives by providing a three-piece golf ball having a solid rubber center, a thread windings layer whose threads are a large gauge and which is wound in an "open" basket weave pattern, a synthetic ionomer resin cover, and a "rhombicosadodecahedron" dimple pattern. The ball of the instant invention has a core compression in the range of 60 PGA to 80 PGA, a center weight in the range of 27.50-28.50 grams, a center size of between 1.34 to 1.37 inches, an unstressed (not wound) thread dimension of about 0.024 ± .004 inches height by 1/16th of an inch width, a cover hardness in the range of about 63 Shore D to about 69 Shore D, and a dimple pattern based on the geometry of a rhombicosadodecahedron. This combination has been found to produce a ball with superior distance capabilities and superior playability capabilities with respect to softness and spin. The use of these properties in the golf ball of the instant invention is based on the recognition that it is the combination of the center size and weight, the size, modulus, and tension of the thread windings, cover hardness, dimple configuration, dimple size and dimple shape that will produce a ball that will travel the greatest distance without compromising shot-making feel.

The golf ball of the present invention has a conventional, solid rubber center or rubber sphere. In a preferred embodiment of the invention, the center has a weight that is slightly heavier than in golf balls manufactured previously. The use of a heavier center is necessary in order to attain a golf ball with sufficient weight to maximize distance and still meet USGA standards. In

particular, as mentioned previously, the instant golf ball has a synthetic ionomer resin cover. This cover has a relatively low specific gravity and as a consequence, a lower weight. Therefore, to manufacture a ball of sufficient weight, a heavier center is used.

The thread of the golf ball of the invention is cut from a sheet that is about 0.020 inches to 0.028 inches in thickness or height. A typical thickness is 0.024 inches, which corresponds to a "gauge" of 24. The width of the thread cut for the instant invention is about 1/16th inch.

It has now been discovered that the combination of a relatively heavy center with a large gauge thread, of about 0.024 ± 0.004 inches, and having relatively low Swartz modulus, and width of about 1/16th of an inch (0.063 ± 0.004 inch), wound to promote an "open" winding pattern under a tension in the range of 925 to 1025 grams of tension produces a ball with improvements in player characteristics. Specifically, the heavy center surrounded by a thread windings layer comprised of a large gauge thread wound to an "open" winding pattern results in a three piece golf ball that spins less than known inventions when it is hit by a driver, while spinning more when it is hit by a pitching wedge. Lower spin off the driver is preferable as it increases the total distance attained from a golf ball.

The use of the relatively large gauge, wide thread, wound to an "open" winding pattern, allows the ionomer resin into which the thread-wound solid rubber center is placed, to penetrate or seep into the thread windings layer to a

greater extent than in the prior art balls. The result is a softer-feeling ball than would be attained otherwise.

The cover material can be constructed from any relatively stiff material, for example, synthetic thermoplastic materials. Most notably these synthetic thermoplastic materials are ionomeric resins. Ionomeric resins are polymers containing interchain ionic bonding. As is well known in the chemical arts, ionomeric resins are generally ionic copolymers of an olefin having from about two to about eight carbon atoms, such as ethylene and a metal salt of an unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, or maleic acid. The pendent ionic groups in the ionomeric resins interact to form ion-rich aggregates contained in a non-polar polymer matrix. Metal ions, such as sodium, zinc or magnesium are used to neutralize some portion of the acidic groups in the copolymer. This results in a thermoplastic elastomer, which exhibits enhanced flight characteristics and durability when compared to golf balls constructed with balata covers. However, the advantages gained by enhanced durability have been offset by the decreased playability properties.

The ionomers used in the cover composition are sold by E.I. Dupont De Nemours & Company under the name SURLYN®. In an attempt to overcome the negative factors of the hard ionomer covers, DuPont introduced low modulus SURLYN® ionomers in the early 1980's. These SURLYN® ionomers have a flexural modulus of from about 3000 to about 7000 PSI and hardness of from 25 to about 40 as measured on the Shore D scale - ASTM 2240. The low modulus ionomers are terpolymers, typically of ethylene, methacrylic acid and <u>n</u> or <u>iso</u>-

butylacrylate, neutralized with sodium, zinc, magnesium or lithium cations. E.I. DuPont De Nemours & Company has disclosed that the low modulus ionomers can be blended with other grades of previously commercialized ionomers of high flexural modulus from about 30,000 to 55,000 PSI to produce balata-like properties. However, soft blends, typically 52 Shore D and lower (balata-like hardness), are still prone to cut and shear damage.

The low modulus ionomers when used without high flexural modulus blends produce covers with very similar physical properties to those of balata, including poor cut and shear resistance. Worse, wound balls with these covers tend to go "out-of-round" quicker than wound balls with balata covers. Blending with hard SURLYN® ionomers was found to improve these properties.

It has now been discovered that a blend of a high resilience ionomer with an associated high acid level with a soft ionomers containing low acid level results in a golf ball cover with improved playability characteristics. For the purposes of the SURLYN® ionomer resin grade designations, a high acid level is approximately 19% by weight, and a low acid level is approximately 12% by weight.

As mentioned previously, in addition to manipulating the center, thread windings layer, and cover parameters in a golf ball, superior aerodynamic properties are also attributed to the dimple configuration on a golf ball. In the instant invention, the dimples are arranged on the surface of the golf ball based on the geometry of a rhombicosadodecahedron.

The golf ball of the instant invention has a dimple pattern that incorporates dimples of different shapes to maximize the aerodynamic properties of the ball.

The dimple shapes may be selected from any known dimple shapes, including but not limited to truncated cones, squares, triangles, dimples within dimples, elliptical surfaces, single radius dimples, and dual radius dimples. The invention allows for the combination of any of the possible dimple shapes into a single dimple pattern to allow a more optimized golf ball flight trajectory.

The golf ball of the preferred embodiment is a hybrid ball in which the dimple pattern on the surface of the ball includes both single radius and dual radius dimples in order to achieve the most optimal flight performance. This hybrid ball is allowed to best utilize the aspects of single radius dimples for shots where it behaves more like a performance three-piece ball, and the aspects of dual radius dimples for shots where it behaves like a distance ball, while maintaining good flight performance and control with a combination of both. The ball provides slightly longer overall distance, and a significantly lower trajectory than the prior art hybrid balls. This is a much desired property for this type of ball.

The dimples are arranged by dividing the outer spherical surface of a golf ball into a plurality of polygonal configurations, including pentagons, squares and triangles for locating a plurality of dimples on the outer surface of the golf ball. The polygonal configurations of this invention are preferably a combination of regular pentagons, squares and triangles to cover the outer surface. This first plurality of polygonal configurations is generally referred to herein as a "rhombicosadodecahedron". The rhombicosadodecahedron is further characterized by a uniform pattern of pentagons formed over the outer surface each bounded by triangles and squares.

The preferred embodiment utilizes a pattern of 402 dimples arranged in the construction of the rhombicosadodecahedron. A pair of first polygonal configurations, each located on opposite sides of the outer surface, include one of the two poles symmetrically arranged within its boundaries. The outer surface has a plurality of dimples of different sizes. In one embodiment, the dimples are of first, second and third sizes and are generally located to have a first pattern associated with the pentagons, a second pattern associated with the squares, and a third pattern associated with the triangles.

In another embodiment of the invention, the outer surface of the golf ball includes a plurality of parting lines along great circle paths of the ball for further dividing the first plurality of polygonal configurations into a second plurality of polygonal configurations, each of which are smaller than the polygonal configurations of the first polygonal configurations. The dimples are arranged over the outer surface by being associated with both the first and the second plurality of polygonal configurations.

The combination of the aforementioned center, thread windings layer, cover and dimple specifications produces a golf ball that possesses noticeable improvements in playability (i.e. softness in feel) without sacrificing the ball's durability (i.e. impact resistance etc.).This combination also contributes directly to the distance that a ball will travel when struck. These and other objects of the instant invention will be apparent from a reading of the following detailed description of the instant invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross sectional view of a three-piece golf ball made in accordance with one embodiment of the invention.

Figure 2 is an elevation view of the outer surface of a golf ball being divided into a plurality of polygonal configurations according to the invention;

Figure 3 is an elevation view of the golf ball of this invention showing the relative locations of pentagons, squares

and triangles formed on the outer surface with a pole at the center of a pentagon;

Figure 4 is an equatorial view of the ball of the preferred embodiment of the present invention, and includes polygons projected thereon.

Figure 5 is a polar view of the ball shown in Fig. 4 and includes polygons projected thereon.

Figure 6 is a cross sectional view of a single radius dimple;

Figure 7 is a cross sectional view of a dual radius dimple; and

Figure 8 is a cross sectional view cut through one of the dimples on the outer surface of the ball.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in Fig. 1, the golf ball is comprised of a solid spherical rubber center **6**, a thread windings layer **4**, and a cover **2** to make a three-piece golf ball. The solid rubber center **6** together with the thread windings layer **4** comprise the core **5** of the golf ball. In the preferred embodiment, the golf ball center **6** has a diameter of about between 1.34 inches to 1.37 inches, preferably 1.354 inches, a

PGA compression in the range of about 40 to about 60, and weighs about 27.5 grams to 28.5grams, preferably about 28.0 grams. When combined, the solid rubber center 6 and the thread windings layer 4 form the core 5 measuring approximately 1.565 ± 0.010 inches in diameter, and having a weight of about 35.0 ± 0.5 grams.

The thread windings layer 4 is comprised of thread cut from sheets of polyisoprene rubber and/or natural rubber and their blends thereof. The unstressed (unwound) thread dimensions are preferably 0.024 inches thickness or height and a thread width of about 1/16th inch. The thread windings are wound in an "open" pattern due to the relatively large size of the thread. The thread windings are wound under a tension from about 900 grams to 1100 grams, to a thread winding thickness of between 0.092 inches to 0..118 inches, preferably about 0.105 inches.

The windings layer of the instant invention has a lower density than is found in other ionomer resin golf balls. Specifically in the preferred embodiment, the unstressed dimensions for thread used in the windings of the golf ball are about 0.020 inches to about 0.028 inches in height, preferably about 0.024 inches, with a width of about 0.059 to about 0.067 inches and preferably 1/16th of an inch. In contrast to a gauge of 24, corresponding to 0.024 inches, the gauge of threads used in other windings is smaller, 17, or 0.017 inches. Advantageously, the use of a large gauge (about 24) thread in the winding layer produces a golf ball that spins less off the driver when compared to a golf ball produced with a smaller gauge (17) thread. This decrease in spin when the instant ball is hit by a

driver occurs as a consequence of the novel construction of a heavy center combined with a thread winding layer that has threads with a lesser density. The larger gauge used for the threads in the thread windings layer results in a golf ball that has a more "open" pattern for the windings. Advantageously, this second design feature for the windings with regard to the "open" winding pattern allows more reactive ionomer resin to penetrate into the core of the golf ball during its manufacture.

The winding conditions for the thread windings layer also contribute significantly to the novel character of the instant ball. In particular, the tension under which the thread is wound affects the PGA compression of the resultant golf ball. In the preferred embodiment, the golf ball is wound at a tension in the range of about 900 grams of tension to about 1100 grams of tension, preferably, 1000 grams of tension. This winding tension produces a golf ball with a core compression in the range of 60 PGA to 80 PGA, preferably 70 PGA. A core compression in this range resulting from the unique character of the thread windings layer, coupled with the heavy center produces a golf ball that is able to maintain great distance and carry while simultaneously having a flight path with a lower trajectory. Advantageously, a lower trajectory in the flight path causes the golf ball to land at an acute angle to the ground. In turn, this acute landing promotes more roll, and thus the golf ball will travel a greater distance when it hits the ground.

In the preferred embodiment, the cover has a thickness of about 0.078 ± 0.015 inches to provide a total diameter of center 6, thread windings layer 4 and

cover 2 of 1.680 inches, the commercial ball diameter standard specified by the United States Golf Association.

As discussed previously, the cover material is comprised of ionomer resins available from E.I. du Pont de Nemours & Co. under the name SURLYN®. In the preferred embodiment, the ionomers are 75% by weight of SURLYN® 8140, and 25% by weight of SURLYN® 9320W. The hardness of the cover 2 is about 66 ± 3 Shore D.

Under the Dupont SURLYN ® resin classification system, the 8140 SURLYN® ionomer is classified as a high resilience ionomer. The 8140 SURLYN® ionomer is defined as a copolymer including approximately 81% of an olefin, most commonly ethylene, and about 19% of an alpha, beta ethylenically unsaturated caboxylic acid, such as acrylic or methacrylic acid. Moreover, this ionomer uses the Sodium metal ion to neutralize the acid groups, and, as stated, its acid level is about 19% by weight, which is considered a high acid level to those skilled in the art. In turn, this high acid level is associated with a resin characterized by a high stiffness level. Moreover, the 8140 SURLYN® grade has no terpolymer. Finally, the 8140 SURLYN® resin has a melt index of about 2.6.

The 9320W SURLYN® resin is classified as a very low modulus ionomer which has a low acid level of about 12 % by weight, which in turn produces a resin characterized by a low stiffness level. The 9320W SURLYN® ionomer is comprised of 67-70% by weight of ethylene, 20-21% by weight of n-butyl acrylate, and 12% by weight of methacrylic acid. In addition, the 9320W SURLYN® resin uses the Zinc

ion to neutralize the acid groups, and it is a terpolymer. Finally, the 9320W SURLYN® resin has a melt index of about 0.7.

In addition to the SURLYN® resins, the cover composition contains color concentrate for coloring the golf ball in an amount well known to those skilled in the art.

Turning now to the dimple technology employed in the instant invention, as stated previously, the preferred geometry is a rhombicosadodecahedron. The dimple configuration will normally be applied to the ball during the molding of the cover around the core by using appropriately shaped compression molding cavitites common to those skilled in the art. The molded golf ball having the desired dimple configuration may be then painted. Alternately, painting may be unnecessary for one-piece golf balls using a cover having a suitable compounding of the composition used.

Accordingly, the scope of this invention provides a golf ball mold whose molding surface contains a uniform pattern to give the golf ball a dimple configuration superior to those of the prior art. The invention is preferably described in terms of the golf ball that results from the mold, but could be described within the scope of this invention in terms of the mold structure that produces a golf ball.

To assist in locating the dimples on the golf ball, the golf ball 1 of this invention has its outer spherical surface partitioned by the projection of a plurality of polygonal configurations onto the outer surface. That is, the formation or division that results from a particular arrangement of different polygons on the

outer surface of a golf ball is referred to herein as a "plurality of polygonal configurations." A view of one side of a golf ball **1** showing a preferred division of the golf ball's outer surface **7** is illustrated in Fig. 2.

In the preferred embodiment, a polygonal configuration known as a rhombicosadodecahedron is projected onto the surface of a sphere. A rhombicosadodecahedron is a type of polyhedron which contains thirty (30) squares, twenty (20) polyhedra of one type, and twelve (12) polyhedra of another type. The term "rhombicosadodecahedron" is derived from "dodecahedron," meaning a twelve (12) sided polyhedron; "icosahedron," meaning a twenty (20) sided polyhedron, and "rhombus" meaning a four (4) sided polyhedron.

The rhombicosadodecahedron of the preferred embodiment is comprised of thirty (30) squares **12**, twelve (12) pentagons **10**, and twenty (20) triangles **14**. It has a uniform pattern of pentagons with each pentagon bounded by triangles and squares. The uniform pattern is achieved when each regular pentagon **10** has only regular squares **12** adjacent to its five boundary lines, and when a regular triangle **14** extends from each of the five vertices of the pentagon. Five (5) squares **12** and five (5) triangles **14** form a set of polygons around each pentagon **10**. Two boundary lines of each square **12** are common with two pentagon boundary lines, and each triangle **14** has its vertices common with three pentagon vertices.

The outer surface of the ball is further defined by a pair of poles and an equatorial great circle path around the surface. A great circle path is defined by the intersection between the spherical surface and a plane that passes through the center of the sphere. An infinite number of great circle paths may be drawn on any

sphere. The equatorial great circle path in the preferred embodiment corresponds to a mold parting line that separates the golf ball into two hemispheres. The mold parting line is located from the poles in substantially the same manner as the equator of the Earth is located from the North Pole and the South Pole.

Referring to Fig. 3, the poles **70** are located at the center of a pentagon **10** on the top and bottom sides of the ball, as illustrated in this view of one such side. The mold parting line **30** is at the outer edge of the circle in this planar view of the golf ball.

Dimples are placed on the outer surface of the golf ball based on segments of the plurality of polygonal configurations described above. In the preferred embodiment, three (3) dimples are associated with each triangle **14**, five (5) dimples are associated with each square **12**, and sixteen (16) dimples are associated with each pentagon **10**. The term "associated" as used herein in relation to the dimples and the polyhedra means that the polyhedra are used as a guide for placing the dimples.

The dimple configuration of the preferred embodiment is shown in Figs. 4-5. It is based on the projection of the rhombicosadodecahedron shown in Fig. 2. The ball has a total of 402 dimples. The plurality of dimples on the surface of the ball are selected from three sets of dimples, with each set having different sized dimples. Dimples **200** are in the first set, dimples **202** are in the second set, and dimples **204** are in the third set. Dimples are selected from all three sets to form a first pattern associated with the pentagon **10**. All sides **206** of each pentagon **10** are intersected by two dimples **202** from the first set of dimples and one dimple **202**

from the second set of dimples. All pentagons **10** have the same general first pattern arrangement of dimples.

Dimples **200, 202** and **204** (from all three sets of dimples) are also used to form a second pattern associated with the squares **12**. All sides **208** of each square **12** are intersected by dimples **202** from the second set of dimples, and all squares **12** have the same general second pattern arrangement of dimples.

Dimples 202 from the second set of dimples form a third pattern associated with the triangles 14. All sides **210** of each triangle **14** are intersected by a dimple **202** from this second set of dimples. All triangles **14** have this same general third pattern arrangement of dimples. The mold parting line **30** is the only dimple free great circle path on this ball.

The ball of the preferred embodiment utilizes two different types of dimples having two different cross-sections, single radius dimples **200** and **204** and dual radius dimples **202**. In the single radius dimple (Fig. 6), a single radius (referred to as a major radius, or Radius 1) describes the shape of the bottom of the dimple. In other words, the major radius governs the shape of the dimple toward the bottom of the dimple. In a dual radius dimple (Fig. 7), on the other hand, two radii are used to describe the shape of the dimple. The major radius describes the bottom of the dimple, and a minor radius (Radius 2) describes the shape of the dimple about its circumference.

Dimple size is measured by a diameter and depth generally according to the teachings of U.S. Patent No. 4,936,587 (the '587 patent), which is included herein by reference thereto. An exception to the teaching of the '587 patent is the

measurement of the depth, which is discussed below. A cross-sectional view through a typical single radius dimple **6** is illustrated in Fig. 8. The diameter **Dd** used herein is defined as the distance from edge **E** to edge **F** of the dimple. Edges are constructed in this cross-sectional view of the dimple by having a periphery **50** and a continuation thereof **51** of the dimple **6**. The periphery and its continuation are substantially a smooth surface of a sphere. An arc **52** is inset about 0.003 inches below curve **50-51-50** and intersects the dimple at point **E'** and **F'**. Tangents **53** and **53'** are tangent to the dimple **6** at points **E'** and **F'** respectively and intersect periphery continuation **51** at edges **E** and **F** respectively. The exception to the teaching of '587 noted above is that the depth **d** is defined herein to be the distance from the chord **55** between edges **E** an **F** of the dimple **6** to the deepest part of the dimple cross sectional surface **6 (a)**, rather than a continuation of the periphery **51** of an outer surface **50** of the golf ball.

The dimple dimensions for the preferred embodiment are set forth below:

Dimple (number)	Diameter (in)	Type	Radius1(in)	Radius 2(in)
200 (60)	.156	Single	.4148	NA
202(150)	.145	Dual	.7874	.1181
204(192)	.140	Single	.3535	NA-

It is understood that the following dimple size ranges are within the scope of this invention: dimples **200** from the first set may have a diameter in the range of 0.150 inches to 0.160 inches; dimples **202** from the second set may have a diameter in the range of 0.140 inches to 0.150 inches; dimples **204** from the third set may have a diameter in the range of 0.135 inches to 0.145 inches; all dimples, **200**, **202** and **204**

may have a depth in the range of 0.0056 inches to 0.0078 inches; the major radius may be in the range of 0.34 inches to 0.80 inches; and the minor radius (for dimple 202) may be in the range of 0.10 inches to 0.12 inches.

The following test data illustrates the improved performance of the dimple pattern of the present invention. Each of the balls identified below is a hybrid ball.

BALL	#DIMPLES	PATTERN TYPE	CARRY(YDS)	TOTAL(YDS)	REAR TRAJ.
BB344	402	all single rad.	247.8	268.0	8.4
BB351	402	all dual rad.	246.3	268.2	8.2
BB370	402	combination	246.6	270.0	8.2
Control	392	all single rad.	245.6	267.5	8.3

As shown above, the ball of the present invention, which utilizes both single radius and dual radius dimples, provides slightly longer overall distance than a ball utilizing either all single radius dimples or all dual radius dimples, and it has a significantly lower trajectory, as exhibited by the lower rear trajectory value. This is a much-desired property for the hybrid ball.

Turning now to the method of manufacturing the instant golf ball, it is to be appreciated that a preferred embodiment of the golf ball is produced according to standard methods well known to those skilled in the art. In particular, the solid rubber center 6 is manufactured using conventional compression molding processes. The components are mixed together and extruded to form preforms, which are then placed in cavities in the mold and are compression molded under pressure and cured or vulcanized to form centers. The same mix may also be injection molded. Curing is carried out in the mold at temperatures of 280°F-380°F

for five to twenty minutes depending on the compound. Once fully cured, the center **6** is removed from the mold cavities and prepared for application of the thread windings layer.

In the preferred embodiment, the golf ball center **6** is made of a solid rubber composition comprising a polybutadiene rubber center of a composition typical to the industry. Specifically, the rubber may be 90-100 PHR polybutadiene, 0-10 PHR polyisoprene, 15-30 PHR zinc diacrylate, 3-10 PHR zinc oxide, 45-65 PHR fillers, activators, process aids and antioxidants, and 0.5-5 PHR peroxide initiator. In the preferred embodiment, the diameter of the solid rubber center **6** is about 1.355 ±0.015 inches. The center **6** weighs about 28.0 ±0.5 grams, and has a compression of about 50 ± 10 PGA.

As is well known in the art, the type and amount of crosslinking agents used to make the center **6** will have the greatest influence on the center compression achieved. To prepare the center **6** according to the preferred embodiment, it has been found that a center composed primarily of high-cis polybutadiene in combination with cross-linking agents, activators, initiators and fillers (active and inactive), can be used to achieve a golf ball center having the desired compression characteristics. As used herein, high-cis means a cis isomer content of greater than 93%. It is to be understood that the center formula set forth herein is but one formula that can be used to make a center having the desired center compression.

Once formed, the solid rubber center **6** is then wound with thread windings in an open pattern with a thread tension from about 900 grams to 1100 grams.

wherein the thread windings have an unstressed thread dimension of about 1/16th of an inch width by about 0.020 inches to 0.028 inches height, and a 500% modulus between 220 to 280 p.s.i.-. The resultant core, 5 is then subjected to a conventional molding process according to standard methods, whereby the SURLYN® cover 2 is compression molded around the wound core 5 in a manner well known to those skilled in the art. In the preferred embodiment, compression molding consists of injecting an ionomer mixture constituting the blended Surlyn® components into 'half shells'. The core is placed between two 'half shells' and then placed into a golf ball mold comprising a first mold half and a second mold half, whereby each of the mold halves are larger in dimension than the finished cover. It should be noted that the inner surfaces of the golf ball mold are constructed with dimple-shaped projections, which form the dimples in the cover in a configuration according to the invention as described above.

After molding, the golf balls produced may undergo further processing steps such as pressure blasting, vibratory finishing, stamping of the logo, application of a primer, and finally, application of a top coat.

The following examples are provided to illustrate and further explain the beneficial effects of the ball described above. These examples are set forth for the purposes of illustrating the advantages obtained with the combination of the center compression, center weight, thread size, thread winding tension, core compression, core size, cover composition, cover hardness, cover thickness, dimple configuration, and dimple number that will produce a ball that will travel the greatest distance without compromising shot-making feel.

EXAMPLE 1

Two flight tests were conducted comparing the flight characteristics of the instant invention, i.e., the Three-Piece Distance Golf Ball, known under the trade name as the Maxfli Tour Patriot, with two other golf balls against which it competes in the marketplace. The golf balls were hit with a driver and various parameters were measured and are summarized below.

Example 1

Ball	Test #2095 **Driver** Carry (yards) Total (yards) Spin (rpm)	Test # 2217 **Driver** Carry (yards) Total (yards) Spin (rpm)
Maxfli Tour Patriot	2[illegible]0.7 272.1 2622	246.0 263.8 2563
Titleist Tour Distance	232.9 266.5 2669	237.9 255.7 2609
Titleist DT Wound		244.2 261.4 2814

Advantageously, as is clearly demonstrated by the test results, the use of a golf ball configured according to the aforementioned center, core, cover and dimple parameters results in a golf ball, the Three-Piece Distance Golf Ball, which has longer flight characteristics than balls manufactured by competitors.

As was discussed previously, the improvements in ball performance of the invention are due to the combination of changes in the center weight, the size and winding conditions of the thread, the cover material, and the dimple pattern of the golf ball. In the invention, the novel manipulation of these parameters creates a ball that spins less and travels further when hit by a driver, while being able to spin more and have superior shot-making feel when hit by a pitching wedge. These two desirable playability characteristics are possible in the instant golf ball due to the unique construction of this ball.

As is known in the art, when a golf ball is hit by a driver, there is great impact force. The whole ball is deformed under this impact force. Consequently, the entire construction of the ball accounts for its initial launch conditions and ensuing flight performance. In the instant invention, the critical difference contributing to the superior distance capability is the center weight, the center compression, the thread windings layer, the core compression, and the cover composition in conjunction with the dimple configuration.

While the present invention has been described in connection with preferred embodiments thereof, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the true spirit and scope of the present invention. It is to be understood that the instant

invention is by no means limited to the particular embodiments herein disclosed, but also comprises any modifications or equivalents within the scope of the claims. For example, it is understood that the invention is not limited to a dimple pattern defined by the rhombicosadodecahedron.

Accordingly, it is intended by the appended claims to cover all such changes and modifications as come within the true spirit and scope of the invention. Having thus described our invention, what we claim as new and desire to secure by United States Letters Patent is: